Optomagnetic biosensor system for DNA and bacteria detection based on rolling circle amplification and immunomagnetic strategies

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Title:

Optomagnetic biosensor system for DNA and bacteria detection based on rolling circle amplification and immunomagnetic strategies

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Introduction: Clearly state the purpose of the abstract

Methods: Describe your selection of observations or experimental subjects clearly

Results: Present your results in a logical sequence in text, tables and illustrations

Discussion: Emphasize new and important aspects of the study and conclusions that are drawn from them

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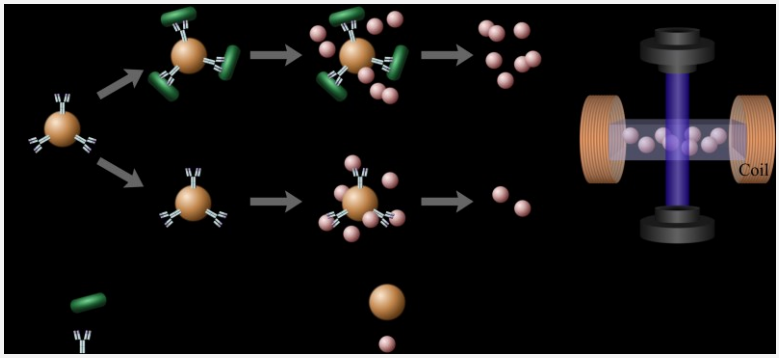
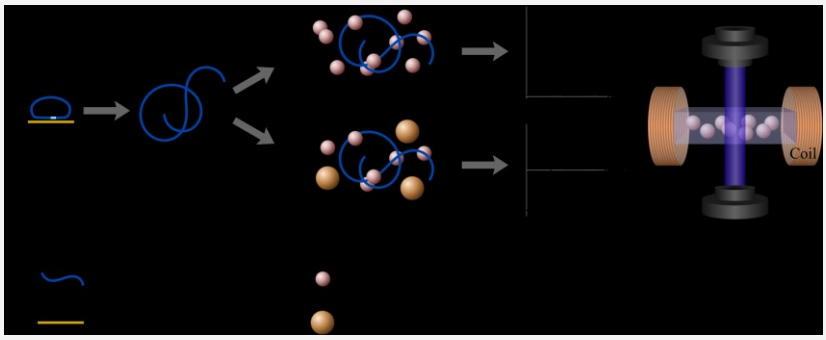
Benefiting from their rapid read-out, highly flexible devices and low-cost portable systems, optomagnetic biosensors have drawn increased attention in recent years as bioassay technologies for small molecules, DNA, and bacteria.

Herein, optomagnetic bioassay strategies are presented utilizing the binding of functionalized magnetic nanoparticles, with Brownian relaxation behaviour, to detect DNA molecules and bacteria. Presence of target changes the dynamic behaviour of the magnetic nanoparticles and thus the optomagnetic response of the sample, which is measured by a 405 nm laser-based optomagnetic setup. The output signal used for target quantification is the in-phase, V_2', and the out-of-phase, V_2'', components of the complex second harmonic signal $V_2 = V_2' + \mathrm{i}V_2''$ of the transmitted light.

A turn-on competitive *Salmonella* immunoassay using two differently sized magnetic particles (micron-sized particles acting as capture particles and nano-sized particles acting as detection particles) is presented resulting in a limit of detection of 8×10^4 CFU/mL (20 times lower than of volumetric magnetic stray field detection device based immunoassays) and a total assay time of 3 h. The improvement of sensitivity is enabled by the formation of immuno-magnetic aggregates providing steric hindrance protecting the interior binding sites from interaction with the magnetic nanoparticle labels. Additionally, a qualitative and homogeneous biplex immunoassay for *E. coli* and *S. typhimurium* is demonstrated.



Using 250 nm “ghost” magnetic nanoparticles, which widen the linear detection range of 100 nm magnetic nanoparticles, the performance of the optomagnetic sensor system for the quantitative analysis of target DNA sequences (through binding of DNA-tagged magnetic nanoparticles to rolling circle amplification products) and bacteria (direct immunoassay protocol) is improved by a factor of 15 compared with the classical approach excluding ghost nanoparticles.



The optomagnetic read-out platform is considered to be a potential candidate for low-cost and easy-to-operate biosensor devices for food safety and veterinary medicine applications.